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March 4-5, 2003
Nanaimo, B.C.

R. Tanasichuk
Salmon Subcommittee Chair

Fisheries and Oceans Canada
Pacific Scientific Advice Review Committee
Pacific Biological Station
Nanaimo, British Columbia V9T 6N7

April 2003

Canada

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PACIFIC SCIENTIFIC ADVICE REVIEW COMMITTEE (PSARC)
SALMON SUBCOMMITTEE MEETING

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SUMMARY

The PSARC Salmon Subcommittee met March 4–5, 2003 at the Pacific Biological Station, Nanaimo, B.C. The Subcommittee reviewed six Working Papers.

Working Paper S2003-01: Pre-season 2003 stock size forecasts for Skeena River and Nass River sockeye salmon

The Subcommittee accepted the forecasts of 1.2 million (50% CI, 835,000 – 1.7 million) for the Skeena River, based on the sibling model, and 768,000 (50% CI, 640,000 – 921,000) for the Nass River, based on the 5-year average (YRA) model.

Based on concern about the status of small, relatively unproductive components of the Skeena aggregate, the Subcommittee recommended that, when possible, stock status of components of stock aggregates should be presented routinely in future PSARC Salmon forecasting papers so that the implications of fishing can be evaluated more effectively.

Working Paper S2003-02: Forecast for mainland inlet pink salmon in 2003

This is the first forecast provided for pink stocks in the mainland inlets of the southern Central Coast area and adjacent regions of northeast Vancouver Island. The Subcommittee accepted the forecasts presented for all six districts. The analyses suggest a harvestable surplus in all areas.

The Subcommittee concluded that the harvestable surplus may be overstated because of potential bias in the forecasting methodology. In addition, the possibility of sea lice infestation should temper pre-season opportunities for harvest.

Working Paper S2003-03: Forecast for southern and central British Columbia coho salmon in 2003.

Forecasts of marine survival for all indicator stocks, abundance of Thompson watershed coho, total returns for Areas 9-13, and distribution of Georgia Basin coho were presented and accepted by the Subcommittee. Marine survival is forecast to be similar to last year (5%) for West Coast Vancouver Island (WCVI) coho and poor for Georgia Basin hatchery indicator stocks. Abundance of Thompson coho is forecast to be lower than in 2002 and would represent 42% of the mean abundance. Returns for Central Coast coho are expected to be average at best and escapements should be at least average except for Johnstone Strait for which escapement will likely be below average. The distribution forecast, based on February salinity, is for a weak "outside" year.

The Subcommittee concluded that marine survival for southern B.C. coho was variable but remained generally low compared to historic levels. Southern B.C. coho survival rates are low (<5%) and high levels of harvest would be unsustainable. Thompson

coho abundances have increased recently but they still remain well below historical levels; if survival remains constant and fisheries do not expand, there will be slow and gradual rebuilding of populations.

The Subcommittee recommended that the qualitative categorization of stock status be standardized across species for future PSARC documents and salmon preliminary outlooks. It was noted that escapement and exploitation rate data for Central Coast coho are considered to be very poor and, until further work is done to improve data quality, careful consideration should be taken before expanding fisheries.

Working Paper S2003-04: Forecast for Northern British Columbia coho salmon in 2003

The Subcommittee accepted the paper and the forecasts. The revision will include abundance estimates for Areas 2E, 2W, and 6. In general, stock abundance is increasing. Marine survival for North Coast indicator stocks is forecast to be above average as are abundance and escapement. However, some high-interior stocks continue to be weak.

The Subcommittee is concerned about the uncertainty of the preliminary abundance estimates for 2002, due to problems associated with the Mark Recapture Program (MRP) which preclude estimating exploitation rate. It recommended that caution be exercised in mixed-stock fisheries that impact high interior Skeena stocks.

Working Paper S2003-05: Forecast for Central Coast (Areas 7 to 10) sockeye, pink and chum salmon in 2003

The Subcommittee accepted the working paper and forecasts. Returns for all sockeye stocks are forecasted to be very low because they are from record low escapements. Chum abundance is expected to exceed the aggregate escapement target in Area 8 only and there is no information for Area 10. Pink abundance is forecast to be near escapement targets in Areas 7 and 8.

The Subcommittee recommended that caution be exercised with respect to Atnarko, Long Lake and Owikeno sockeye by-catch. In addition, chum salmon enumeration is required in the Broughton Archipelago and streams from Kingcome to Loughborough inlets due to the possibility of a recruitment failure due to sea lice infestations in 2001 and 2002.

Working Paper S2003-06: Review of the Year 2002 Return of Barkley Sound Sockeye Salmon and Forecasts for 2003

The Subcommittee accepted the forecasts and the working paper. The Survival Stanza Model forecast for 2003 is 993,000 (50% CI, 667,000 – 1.30 million) for all ages and 922,000 (50% CI, 619,000 – 1.24 million) for adults. A similar forecast was obtained from another recently developed model, the Coho Leading Indicator, which assumes

that sea conditions shared during early marine migration cause similar trends in the survival of coho and sockeye.

The Subcommittee expressed concern that Henderson Lake has not achieved its escapement target of 50,000 since 1994. The senior author noted that a Stock Status Paper on Henderson Lake sockeye will be presented at the May 2003 Salmon PSARC meeting. The Subcommittee recommended that consideration be given to managing fisheries in 2003 to avoid Henderson Lake sockeye, perhaps by modifying the timing and location of fisheries in Barkley Sound.

SOMMAIRE

Le Sous-comité du saumon du CEESP s'est réuni les 4 et 5 mars 2003 à la Station biologique du Pacifique, à Nanaimo (C.-B.), pour passer en revue six documents de travail.

Document de travail S2003-01 : Prévisions d'avant-saison de la taille des stocks de saumon rouge des rivières Skeena et Naas en 2003

Le Sous-comité accepte les prévisions de 1,2 million d'unités dans la Skeena (IC de 50 %, 835 000 – 1,7 million), établies à partir du modèle de régression sur les germains, et de 768 000 unités dans la Naas (IC de 50 %, 640 000 – 921 000), déterminées à partir du modèle de la moyenne quinquennale.

Préoccupé par les petites composantes relativement non productives des stocks de la Skeena, le Sous-comité recommande que leur état soit, dans la mesure du possible, présenté régulièrement dans les futurs documents sur les prévisions établis pour le CEESP, de sorte à pouvoir évaluer plus efficacement les répercussions de la pêche.

Document de travail S2003-02 : Prévisions pour le saumon rose des inlets continentaux en 2003

Il s'agit des premières prévisions pour les stocks de saumon rose des inlets continentaux du sud de la côte centrale et des régions adjacentes du nord-est de l'île de Vancouver. Le Sous-comité accepte les prévisions présentées pour les six districts. Selon les analyses, il y aurait un surplus exploitable dans toutes les régions.

Le Sous-comité conclut que ce surplus est peut-être surestimé à cause de la distortion potentielle dans la méthodologie utilisée pour faire les prévisions. En outre, la possibilité d'une infestation par le pou du poisson devrait tempérer les possibilités de pêche avant la saison.

Document de travail S2003-03 : Prévisions pour le saumon coho des côtes Sud et centrale de la Colombie-Britannique en 2003

Le Sous-comité accepte les prévisions qui lui ont été présentées sur la survie en mer pour tous les stocks indicateurs, sur l'abondance du coho dans le bassin de la Thompson, sur les remontes totales pour les zones 9-13 et sur la distribution du coho dans le bassin de Georgia. Le taux de survie en mer devrait être semblable à celui de l'an dernier (5 %) pour les stocks de la côte Ouest de l'île de Vancouver et être nettement faible en ce qui concerne les stocks d'écloserie indicateurs du bassin de Georgia. L'abondance du coho dans la Thompson devrait être inférieure à celle de 2002 et représenterait 42 % de l'abondance moyenne. Les remontes de coho de la côte centrale devraient être moyennes dans le meilleur des scénarios, et les échappées être au moins moyennes, sauf dans le détroit de Johnstone où elles seront probablement inférieures à la moyenne. D'après les taux de salinité observés en février, la distribution serait modérément élevée dans les eaux extérieures du détroit de Johnstone.

Le Sous-comité conclut que la survie en mer du coho du sud de la province était variable, mais demeurait généralement faible comparativement aux niveaux historiques. Les taux de survie en mer de ces stocks sont faibles (< 5 %), et des niveaux de capture élevés seraient impossibles à soutenir. L'abondance du coho de la Thompson a augmenté récemment, mais elle demeure bien inférieure aux niveaux historiques; si le taux de survie demeure constant et que la pêche ne prend pas d'expansion, il y aura un faible rétablissement graduel des populations.

Le Sous-comité recommande de normaliser la catégorisation qualitative de l'état des stocks pour toutes les espèces dans les futurs documents soumis au CEESP et dans les prévisions préliminaires sur le saumon. Les données sur les échappées et les taux d'exploitation du coho de la côte centrale sont considérées comme étant très pauvres et, en attendant que leur qualité soit améliorée, il faudrait faire preuve de prudence avant d'étendre la pêche.

Document de travail S2003-4 : Prévisions pour le saumon coho de la côte Nord de la Colombie-Britannique en 2003

Le Sous-comité accepte le document et les prévisions. Le document révisé comprendra des estimations de l'abondance pour les zones 2E, 2W et 6. En général, l'abondance des stocks est à la hausse. La survie en mer des stocks indicateurs de la côte Nord devrait être supérieure à la moyenne, à l'instar de l'abondance et des échappées. Cependant, certains stocks de la partie intérieure du bassin de la haute Skeena continuent d'être appauvris.

Le Sous-comité est préoccupé par l'incertitude des estimations préliminaires de l'abondance pour 2002 en raison des problèmes associés au Programme de reprise de poissons étiquetés qui empêchent d'estimer le taux d'exploitation. La prudence est

recommandée dans le cas de la pêche de stocks combinés qui influe sur les stocks de la partie intérieure du bassin de la haute Skeena.

Document de travail S2003-5 : Prévisions pour le saumon rouge, le saumon rose et le saumon kéta de la côte centrale (zones 7 à 10) en 2003

Le Sous-comité accepte le document de travail et les prévisions. Les remontes devraient être très faibles dans le cas de tous les stocks de saumon rouge puisqu'ils proviennent d'échappées dont le nombre n'a jamais été aussi bas. L'abondance du saumon kéta devrait dépasser la cible d'échappées des stocks dans la zone 8 seulement, et on ne dispose d'aucune information pour la zone 10. L'abondance du saumon rose devrait approcher les cibles d'échappées dans les zones 7 et 8.

Le Sous-comité recommande la prudence à l'égard des prises accessoires de saumon rouge de la rivière Atnarko et des lacs Long et Owikeno. En outre, il est nécessaire de dénombrer les saumons kétas dans l'archipel de Broughton et les cours d'eau des inlets Kingcome à Loughborough en raison de l'échec possible du recrutement attribuable à l'infestation par le pou du poisson en 2001 et 2002.

Document de travail S2003-06 : Examen des remontes de saumon rouge dans la baie Barkley en 2002 et prévisions en 2003

Le Sous-comité accepte les prévisions et le document de travail. Les prévisions de 2003 établies à l'aide du modèle de Stanza pour la survie sont de 993 000 unités de tous les âges (IC de 50 %, 667 000 – 1,30 million) et de 922 000 adultes (IC de 50 %, 619 000 – 1,24 million). Des prévisions semblables ont été obtenues d'un autre modèle récemment mis au point, l'indicateur avancé des remontes de saumon coho, qui postule que le saumon coho et le saumon rouge exposés aux mêmes conditions océaniques au début de leur migration présenteront des tendances semblables en matière de survie.

Le fait que la cible d'échappées de 50 000 unités n'ait pas été atteinte dans le cas du stock du lac Henderson depuis 1994 préoccupe le Sous-comité. L'auteur principal a indiqué qu'un rapport sur l'état de ce stock sera présenté à la réunion de mai 2003 du Sous-comité du saumon du CEESP. Le Sous-comité recommande que l'on envisage de gérer les pêches en 2003 de façon à éviter le saumon rouge du lac Henderson, peut-être en modifiant les périodes et les lieux de pêche dans la baie Barkley.

INTRODUCTION

The PSARC Salmon Subcommittee met March 4-5, 2003, at the Pacific Biological Station in Nanaimo, British Columbia. External participants from the Pacific Fisheries Resource Conservation Council, B.C. Fish and Wildlife Federation, Shuswap Nation Fisheries Commission, Fishing Vessel Owners Association, and the Sport Fish Advisory Board attended the meeting. Observers included a member of the public and representatives of the Area G Troll Association and the Fraser River Aboriginal

Fisheries Secretariat. The Subcommittee Chair, R. Tanasichuk, opened the meeting by welcoming the participants. During the introductory remarks the objectives of the meeting were reviewed, and the Subcommittee accepted the meeting agenda.

The Subcommittee reviewed six working papers. Summaries of the working papers are in Appendix 1. The meeting agenda appears as Appendix 2. A list of meeting participants and observers is included as Appendix 3.

None of the working papers were sent out for external review prior to the meeting. This is largely due to PSARC-endorsed methodologies being applied for all forecasts. However, most papers were not submitted in time to allow for internal or external reviews. This seemed to be due to problems with timely data transfer to the authors and/or the timing of the meeting in relation to the biology of the stocks considered, especially WCVI chinook.

DETAILED COMMENTS FROM THE REVIEW

S2003-01: Pre-season 2003 stock size forecasts for Skeena River and Nass River sockeye salmon

S. Cox-Rogers (**Accepted with revisions**)

Subcommittee Discussion

Data, forecasting models and forecast performance

This working paper used data and forecasting methods used in previous PSARC assessments. Reconstructed catches of Skeena and Nass Rivers sockeye in mixed-stock fisheries in Alaska and northern British Columbia were based on reconstructions for 1982-92. The author noted that these will be updated in 2003 based on new tagging and DNA information. For the Skeena, total returns in 2002 were 1.5 million sockeye and the sibling model predicted 1.2 million sockeye (error=+21%). Returns to the Nass River were about 1 million sockeye which was above the forecast made using the 5-yr mean model (685,000; error=+46%). Forecasts for both rivers were within the 90% confidence interval of the forecasts.

Stock status

Average sockeye returns to the Skeena River have increased steadily (with occasional poor years) since enhancement began in the early 1970s. Returns over the 1990s have ranged between 0.8 million in 1998 and 6.9 million in 1996. They were very strong in 2000 (4.7 million) and 2001 (4.6 million) but declined to 1.5 million in 2002. Escapements in the 1990s have met or exceeded the target (1.1 million) in all years except 1998, 1999, and 2002. Returns for 2003 are from brood years (1998, 1999) for which escapements were below target. Returns of younger fish from these brood years are relatively low. Enhanced escapements in the Skeena have been increasing. Wild

escapement has been decreasing and/or stabilizing at lower levels. Wild smolt production is below capacity.

Nass River total returns have been relatively stable over time, ranging between 500,000 and 1.0 million sockeye since the mid-1990s. Mean returns over the 1990s were slightly less than 1.0 million fish. Target escapement (200,000) was met in most years in the 1990s. The total return to the Nass River in 2002 was slightly greater than 1 million fish and escapement was 405,000 sockeye.

Recommended forecast

Returns to the Skeena River in 2003 of age 5_2 and 4_2 sockeye are expected to be relatively low because the escapements for 1998 and 1999 were below target. Preliminary in-season indications from the 2001 and 2002 fisheries show low returns for these brood years. The recommended forecast for the Skeena River, based on the sibling model, is 1.2 million sockeye (50% CI, 835,000 – 1.7 million). An average return is expected for the Nass River. The Nass River forecast, based on the 5-yr mean model, is 768,000 (50% CI, 640,000 – 921,000).

Subcommittee Conclusions

The Subcommittee accepted the paper subject to revisions and the forecasts presented (Table 1).

The author noted that a Stock Status paper for Skeena sockeye will be presented at the May PSARC meeting. This paper will identify individual stocks which appear to be at low levels. The Subcommittee expressed concern that smaller, less productive stock components of the aggregates may be exposed to unsustainable exploitation rates.

Subcommittee Recommendations

The Subcommittee recommended that the sibling model forecast be used for Skeena sockeye because the sibling model has performed well for this stock in the past and it is the most conservative forecast for 2002. It was noted that the forecast is slightly above the target escapement. The 5-yr mean forecast performed better than other candidate models for the Nass River. In addition, the Subcommittee recommended that, when possible, stock status of components of stock aggregates should be presented routinely in future PSARC Salmon forecasting papers so that the implications of fishing can be evaluated more effectively.

S2003-02: Forecast for mainland inlet pink salmon in 2003
L.B. Holtby (**Accepted with revisions**)

Subcommittee Discussion

Data, forecasting methods and forecast performance

For the first time, forecasts are provided for pink stocks in the mainland inlets of the southern Central Coast area and adjacent regions of northeast Vancouver Island. All data were assembled from DFO catch and escapement databases updated and maintained by staff in the Central Coast area. Escapement data are mostly visual estimates from aircraft and the accuracy and precision of the counts is unknown and expected to be poor. Escapement records for any one stream are fragmentary and very few systems have complete or nearly complete time series. Peak counts are believed to provide a reasonable index of abundance. An annual time series of escapement indices for each of the six districts was developed as the mean proportion of maximum observed escapement over streams within a district. An estimate of exploitation rate was then used to calculate an index of total returns, which was in turn used for the time series and stock-recruitment forecasting models. Catch was partitioned among streams based on the proportion of total study area escapement attributed to a specific stream. Forecasting methodologies used for central and northern B.C. pink stocks were applied.

The Subcommittee noted that the stock productivity parameter and exploitation rates appear to be unusually high. This may be due to stock-recruitment parameter estimation bias.

Results of retrospective analyses showed that the best-performing time-series model was the overall average model. However, stock size is highly variable and there are few indications of abundance stanzas in most districts. The stock-recruitment model was more accurate than the time series models.

Stock status

Total returns and escapements for North East Vancouver Island (NE-VI) pinks have increased from a low period in the 1970s to near Maximum Sustainable Yield (MSY) for the past two cycles. Abundance of pinks from the Johnstone Strait district were above MSY from 1987 to 1999. An historical low was observed in 2000. The stock recovered in 2001. Mid-eastern Vancouver Island pink salmon abundance has increased steadily since the late 1960s and reached a record high in 2001. Pinks from Kingcome Inlet declined markedly over the 1990s and then increased to near-MSY levels in 2001. The abundance of pink salmon from Bond Sound to Knight Inlet has fluctuated around MSY over the abundance time series. Loughborough and Bute inlets pinks declined over the 1990s and increased to near the long-term mean for 2001. In general, the escapements appear to have been around S_{MSY} and fisheries management appears to have been appropriate for the majority of the stock aggregates (e.g. EVI, Kingcome,

and Loughborough), except NE-VI. The Subcommittee noted that the increase in abundance between 1999 and 2001 may be due to increased marine survival, as was observed for Fraser River pinks. In addition, Kingcome Inlet is one of the areas of concern over fish lice and there may be some concerns with Loughborough and Bute inlets because survivals were low, but it was not clear if sea lice abundance was a dominant factor.

Recommended forecast

As for other pink forecasts, those for Central Coast mainland inlet pinks are very uncertain. Forecasts (Table 2) are presented relative to median returns and the theoretical management parameters derived from Ricker stock-recruit models. At the 50% forecast level, harvestable surpluses are expected in all districts. The stock-recruitment models are highly uncertain and it is strongly recommended that a forecast value more conservative than the point forecast be used to determine permissible exploitation rate bounds. In addition, if exploitation is in mixed stock areas, exploitation rates should be in the context of the weakest stock to be impacted. There are some preliminary indications of an inverse log-linear relationship between recruits/spawner and mean sea surface temperature over March through May for Pine Island. Finally, the possibility that the sea lice infestations observed in 2002, although reported to be less severe than those seen in 2001, could impact survival of the Bond/Knight district, should temper pre-season expectations of harvest.

Subcommittee Conclusions

The Subcommittee accepted the paper with revisions. The author was asked to include a cautionary note about the S_{MSY} estimates. If there is an inherent bias, then the fishing opportunity(s) may be overstated. At this point the estimates of productivity and exploitation rates should be viewed as an upper bound of productivity and exploitation. These parameters appear to be higher than those estimated for Fraser River pinks.

The possibility of sea lice infestation should temper pre-season opportunities for harvest. Fisheries planning should recognize that there is a possibility of recruitment failure.

Caution should be applied to pink salmon in the area of interest until a better understanding of current observations is developed. Perhaps this caution should be restricted to Wakeman Sound, Bond Sound, Knight Inlet, and possibly the southern part of Johnstone Strait. Nothing observed to date discounts the possibility that sea lice was a dominant factor in the recruitment failure. Sea lice infestations were observed in the spring of 2002 and were not quite at the same high levels as in 2001, but may be a factor that influences recruitment. There has been recruitment failure noted in some of these areas in recent years and this may occur again.

Subcommittee Recommendations

There appears to be harvestable surplus in all these areas, but this may be overstated because of stock-recruitment parameter estimation bias.

Recruitment failure occurred in 2002 in Bute Inlet, Kingcome Inlet, and Bond Sound to Knight Inlet. The Subcommittee recommended cautious management given the occurrence of previous recruitment failures and the reported abundance of sea lice in 2001 and 2002. In 2003, extensive new work will occur in Knight Inlet, Kingcome Inlet, and Broughton Archipelago on factors responsible for the recruitment failure, including sea lice.

S2003-03: Forecast for southern and central British Columbia coho salmon in 2003

K. Simpson, M. Chamberlain, J. Fagan, B. Holtby, R. Sweeting and R. Tanasichuk
(**Accepted with revisions**)

Subcommittee Discussion

Data, forecasting methods and forecast performance

The authors presented forecasts of marine survival rates for southern B.C. coho, abundance forecasts for interior Fraser and Central Coast (Areas 7-13) coho and a catch distribution forecast for Strait of Georgia coho (outside the Strait, WCVI, versus inside the Strait). Marine survival rates were forecast using methods approved in previous working papers. As recommended at the March 2002 Subcommittee meeting, a total return forecast for interior Fraser coho was made using a forecast of returns per spawner and the estimated escapement for 2000. In addition, it was not necessary to correct sibling forecasts for varying number of smolts; the Subcommittee concluded that this modification was unnecessary. Information from the Salmon River, the lower Fraser wild coho indicator, has also been incorporated. The methodologies applied were previously approved by PSARC. The Subcommittee requested that, in future, smolt data used in a particular forecast should be presented in the paper as a figure showing the distribution of historical smolt estimates and the forecast value indicated in the distribution. In addition, stock-recruitment models should be developed for future forecasting papers to increase the range of candidate forecast models. These models would address both freshwater and marine survival effects while considering effects of parental abundance on recruit production. Finally, stock-recruitment models have the potential to provide benchmarks relative to productivity and capacity (eg. S_{MSY}).

The following table presents the performance of the marine survival rate forecasting models for Georgia Basin and WCVI coho in 2002 (the Georgia Basin hatcheries GB hatcheries) value is the mean):

	Stock							
	Quinsam	Big Qualicum	Chilliwack	Inch	GB Hatcheries	Black	Robertson	Carnation
Observed survival in 2002	0.013	0.016	0.033	0.021	0.021	0.049	0.047	0.051
Sibling forecast	0.023	0.070	0.041	0.023	0.039		0.031	0.161
% obs of forecast	56%	23%	80%	90%	53%		150%	32%
Quasi TS model	3YRA	LLY	RAT3	3YRA		3YRA	LLY	3YRA
Forecast	0.013	0.021	0.035	0.026	0.024	0.030	0.092	0.031
% obs of forecast	99%	77%	94%	79%	87%	162%	51%	164%
Euphausiid forecast								0.040
% obs of forecast								127%
CPUE forecast					0.034			
% obs of forecast					61%			

The models with the best retrospective performances (lowest RMSE and MAD scores up to the 2002 return year) are shaded. Overall, forecast accuracy for 2002 was better than average.

Abundance forecasts for interior Fraser coho were made using the 3YRA (3-year average) models. The forecasts were 0.36, 0.50, 0.55 and 0.48 of the observed mean abundances for Lower Thompson, South Thompson, North Thompson and Thompson watersheds respectively. As requested by the Subcommittee in 2002, a return per spawner forecasting method was evaluated. Results indicated that the abundance-based models performed better (Table 3).

The abundance of Central Coast coho (Statistical Areas 7, 8, and 13) were overforecast in 2002. Forecasts for 2002 were not made for Statistical Areas 9/11 and 12. The over-forecasts may be due to unusually low water conditions during the fall and early winter of 2002 and premature cessation of the escapement surveys.

Stock status

The Subcommittee felt that the qualitative descriptions of stock status should be standardized over species and in documents addressing stock status, such as Outlooks and PSARC forecasting papers.

Survival rates for all southern B.C indicator stocks declined in 2002 (Fig. 1). The 2002 marine survival rate estimates for WCVI wild (Carnation Creek, 5.1%) and hatchery (Robertson Creek, 4.7%) indicator stocks declined by 13 and 51% respectively. Wild survival rates are at the most recent 10-year mean but below the 27 year time-series average of 9.1%. Hatchery survival rates are at the most recent 5-year average and the long-term mean. Marine survival rates for Georgia Basin wild and hatchery indicator stocks are considered to be poor. They declined by an average of 32% in

2002 and were similar to the average rate since the mid-1990s. Survival rates for the lower Fraser wild and hatchery indicators was greater than for east coast Vancouver Island coho and declined by 51 and 2% respectively in 2002.

Abundance and escapements of Thompson coho in 2002 were similar to those in 2001. These indicators of stock status suggest recovery to early 1990s levels. The escapement in 2002 was the second largest since 1989 and escapements in 2001 and 2002 were larger than the brood year escapements.

Returns of Central Coast coho in 2002 were near to or below 2001 levels in all Areas except 7. Returns for Area 7 appear to be increasing from the late 1980s – early 1990s minimum whereas returns for Area 8, 12, and 13 have not. Returns for Areas 9-11 appear to be average.

Recommended forecast

Marine survival rate forecasts for Georgia Basin, lower Fraser and WCVI coho stocks are summarised in Table 4. Poor survival, similar to or less than that observed in 2002, is forecast for the Georgia Basin hatchery indicator stocks in 2003. Results are consistent among forecasting models. The forecasted survivals for lower Fraser indicator stocks are similar to those observed over the later 1990s. Survival rates for wild and hatchery WCVI coho are predicted to be similar to those observed in 2002, in the range of 4 to 6%. The Subcommittee noted that abundance forecasts for Management Units need to be developed to meet Pacific Salmon Treaty needs. For the Canadian component of FRAM (U.S. Fishery Regulation Assessment Model) abundances of aggregates relative to the baseline period need to be provided. The senior author prepared these abundance forecasts in the table below for the second day of the meeting.

	Confidence Limits	Forecast Return	Optimum Escapement	ER[1]	Status[2]
Black (GBW):	25%	2,650	3,150		
	50%	**3,800**		**0.17**	**Low**
	75%	5,390		0.42	
Salmon (LwFr):	25%	3,530	4,000 [4]	0.00	
	50%	**4,640**		**0.14**	**Low**
	75%	6,110		0.35	
Carnation (wVI):	25%	250	90	0.64	
	50%	**260**		**0.65**	**Moderate[3]**
	75%	27		0.67	

[1] Exploitation rate (ER) that will result in the optimum escapement at the forecast

abundance.
[2] PST status based on ER needed to achieve optimum escapement.
[3] Status for wVI is considered Moderate, due to evidence that the Carnation return was exceptionally large for the SWVI and NWVI Management Units.
The optimum ER indicates that the status of Carnation coho is Abundant.
[4] Optimum escapement for Salmon R. (Langley) is poorly determined.

Abundance forecasts for Thompson coho are presented in Table 5. The forecasted return is about 36,000 coho which is 42% of the mean abundance for the time series and slightly more than one-half the observed abundances in 2002.

Table 6 summarizes the forecasts for the Central Coast aggregates. The 3YRA model was the best in all cases. Total returns are forecast to be no better than below average except for Area 9/11 coho for which returns are expected to be average. If fisheries do not expand over 2002 levels, escapement is forecast to be at least average for all aggregates excluding Johnstone Strait for which escapement will likely be below average.

The salinity forecast yields a distribution index of 0.46. This is based on an historic prediction of the proportion of the coho catch taken inside versus outside the Strait of Georgia when there were intensive fisheries in both areas (up to 1998). It is assumed that changes in this index reflect qualitative changes in coho distribution.

Subcommittee Conclusions

Marine survival for southern B.C. coho was variable but remained generally low compared to historic levels. Southern B.C. coho survival rates are low (<5%) and high levels of harvest would be unsustainable. WCVI coho abundance is near average and survival is not improving. Thompson coho abundances have increased recently but they still remain well below historical levels; if survival remains constant and fisheries do not expand there will be slow and gradual rebuilding of populations. Abundance in Areas 7, 8, 12 and 13 are forecast to be below average in 2003. Escapements are expected to be average in all Central Areas except Area 13 if fisheries do not expand.

Subcommittee Recommendations

The Subcommittee accepted the paper, subject to minor revisions, and the forecasts presented. There was a general recommendation to implement consistent qualitative categories of stock status in future PSARC documents and salmon preliminary outlooks. It recommended that the categories be reviewed and standardized as an agenda item at the May Salmon PSARC meeting. The Subcommittee also recommended that a stock status report of Area 12 & 13 coho be prepared for the Fall 2003 or May 2004 Salmon PSARC Subcommittee meeting because of the long downward trend in escapements of monitored systems. Escapement and exploitation rate data for Central Coast coho are considered to be very poor and, until further work is done to improve data quality, careful consideration should be taken before expanding

fisheries. Any fisheries on the WCVI should be cautious. Marine survival rates of Thompson coho are expected to remain low and no significant changes in harvest levels are recommended.

S2003-04: Forecast for Northern British Columbia coho salmon in 2003
J. Sawada, L. B. Holtby and B. Finnegan (**Accepted with revisions**)

Subcommittee Discussion

Data, forecasting methods and forecast performance

This working paper presents a marine survival and total return forecast for the Lachmach River (Area 3) wild indicator stock, a marine survival forecast for Toboggan Creek and Fort Babine hatchery indicators (Area 4) and a return and escapement forecast to Babine Lake (Area 4). Input data and forecast methodologies used for this paper were PSARC-approved and have been used in previous forecasts. A sibling regression is used to forecast returns to the Lachmach River and the covariation of Lachman River, Zolzap Creek, Toboggan Creek and Fort Babine survival rates allows forecasts for the latter three systems to be made from Lachman River survival rates. Coded-wire tag data for the 2002 return year was not resolved in time. Therefore, the regression included data up to the 2001 return year.

The Subcommittee expressed concern that the P_{max} forecasts of other stocks in the region were not done. After considerable discussion regarding data quality, the consensus was that P_{max} forecasts for Areas 2E, 2W, and 6 would be included in the revision because there is information on trends in abundance. The Subcommittee also expressed concern regarding a degradation in MRP North Coast catch and sampling information.

Stock status

Four indicator sites (Zolzap Creek, Lachmach River, Toboggan Creek Community Development Project (CDP), Fort Babine (CDP) are used to determine the status of North Coast coho. Escapements to Zolzap Creek and the Lachmach River were the highest in the time series, and the third highest for the Toboggan Creek time series. No data are available for Fort Babine hatchery fish because the 1999 brood year suffered 100% mortality. All other counting operations suggest relatively high escapement, where there is confidence in the data. Sixty-four coho were counted at the Sustut River fence. This is the third highest in the 10-year time series where counts have ranged between 5 and 120.

Recommended forecast

Survival for Lachmach River, Toboggan Creek hatchery and Fort Babine hatchery coho are forecast to exceed the time series means (Table 7). Abundance and escapement are forecast to be average or better. Coho have appeared to respond strongly to

reduced fishing pressure and several years of above-average marine and freshwater survival. However, some high interior stocks (eg. Sustut River) continue to be weak.

Subcommittee Conclusions

Escapements appear to have increased since fisheries were reduced. The Subcommittee is concerned that the total abundance estimates for 2002 are uncertain because of problems associated with Mark Recapture Program (MRP) which preclude estimating exploitation rate.

Subcommittee Recommendations

The Subcommittee recommended that the working paper be accepted with revisions and that the forecasts be accepted. Caution should be exercised in mixed-stock fisheries that impact high interior Skeena stocks.

S2003-05: Forecast for Central Coast (Areas 7 to 10) sockeye, pink and chum salmon in 2003
L. Blair Holtby, P. Van Will, and D. Lewis (**Accepted with revisions**)

Subcommittee Discussion

Data, forecasting methodology and forecasting performance

The data and forecasting methods used for the 2003 forecasts were identical or similar to those that have been approved by PSARC for previous assessments. There were data deficiencies. No data were available for Kimsquit sockeye (Area 8) or Area 10 chum and pink since 2000. The Subcommittee was concerned about the lack of data for Area 10 and it is unclear why data are not available to Stock Assessment staff.

The forecasting models used were the 5YRA (5-year average) and 3YRA (3-year average) for sockeye, the nYRA (identical to the long-term mean model) for chum and the Ricker stock-recruitment model for pink. The performance of the 2002 forecasts is summarised below. Chum but especially sockeye were under-forecast. Pink returns were under-forecast in Area 9 and over-forecast in Areas 7 and 8.

				No. fish (thousands)		Error		
Species	Area	Stock	Method	Forecast	Observed	No. Fish	Percent	Approx. *p*
Sockeye	8	Atnarko	5YRA	27	59	32	54	<0.9
	9	Owikeno	5YRA	30	100	70	70	<0.95
	10	Long	5YRA	11	92	81	88	<0.99
Chum	7	All	Average	300	460	160	35	<0.9
	8	All	Average	440	610	170	29	<0.75
	9	All	Average	42	87	46	52	<0.9
Pink	7	All	Ricker	490	460	-33	-7	0.5
	8	All	Ricker	3,900	3,200	-680	-21	<0.5

Species	Area	Stock	Method	No. fish (thousands)		Error		Approx. p
				Forecast	Observed	No. Fish	Percent	
	9	All	Ricker	350	750	410	55	<0.9
	10	All	Ricker	43	ND*			

*Not Determined

Stock status

Sockeye returns to Atnarko, Long and Owikeno lakes in 2002 approached the escapement targets but there continues to be no information for Kimsquit Lake (Fig. 2). Chum abundances appear to be stable in Areas 7 through 9 but was severely depressed in Area 10 in 1999 when last enumerated. For Areas 7, 8, and 9, escapement continues to be below the target, and recently has exceeded S_{MSY} (Fig 3). Pink abundance in Areas 8 and 9 have recently fluctuated around MSY and abundance in Area 7 in 2001 approached MSY (Fig. 4). The status of Area 10 pinks is unknown because of no enumeration. Considerable concern for Atnarko, Owikeno and Long lakes sockeye was expressed because the next three years will see the returns for the record low escapements for 1999 and 2000.

The Subcommittee re-iterated its concern regarding forecasts for aggregates which include both dominant, relatively productive stocks and smaller, less productive ones. The status of Area 8 chum is unknown with respect to the role that enhanced stocks have played in influencing recent return trends.

Recommended forecast

Recommended forecasts for Central Coast sockeye, pink, and chum are presented in Tables, 8, 9, and 10 respectively. Sockeye returns (50% probability) are all expected to be under escapement targets because the 1998 and 1999 escapements were among the lowest on record. Abundance of pinks in Areas 7 and 8 is forecast to be near escapement targets at the 25% level. The forecast for Area 9 is highly uncertain. Chum abundance is expected to exceed the escapement at MSY in Areas 7 through 9 and target escapement in Area 8 only.

Subcommittee Conclusions

The Subcommittee accepted the paper with minor revisions and accepted the forecasts. There has been a surplus identified for Area 8 chum but there are sockeye by-catch concerns.

Subcommittee Recommendations

Caution should be exercised with respect to Atnarko, Long Lake and Owikeno sockeye to avoid all harvest whether directed or incidental. Some chum enumeration effort is required in the Broughton Archipelago and streams from Kingcome to Loughborough inlets given the possibility of a recruitment failure due to sea lice infestations in 2001 and 2002.

S2003-06: Review of the year 2002 return of Barkley Sound Sockeye Salmon and Forecasts for 2003

K. Hyatt, W. Luedke, P. Rankin, J. Till and D. Lewis (**Accepted with revisions**)

Subcommittee Discussion

Data, Forecasting methodology and forecasting performance

Forecasts in this working paper were made using the historic time-series and methodology for previous assessments. The Subcommittee approved the data used and the methodology. The following table describes the performance of the three methods (SSM –Salinity Survival Method; SStM–Survival Stanza Method; SEPB – Salmonid Enhancement Programme Biostandard Method):

Forecasting Method	Percent error over forecasting interval 1988-2002; MAPE – mean absolute percent error	2002
SSM	68	-51
SStM	28	13
SEPB	58	28

Stock status

Table 11 presents escapements for Barkley Sound sockeye for 1977-2002. The escapement into Great Central and Sproat lakes has averaged 364,000 sockeye over 1977 to 2001, ranging from between 152,000 in 1978 to 786,000 in 2001; it was about 521,000 in 2002. Total returns were about 1.1 million in 2002; this was 135% of most recent 20-year average (829,000) and is the second consecutive year of above average returns. Henderson Lake has a target escapement of 50,000. The average escapement into Henderson Lake and Clemens Creek over 1977 to 2001 was 28,343, ranging from a low of 3,000 in 1995 to a high of 120,000 in 1993. The preliminary estimate of more than 16,000 adults into Henderson Lake is a substantial increase from the estimate of 3,633 observed in 2001. The Subcommittee noted that Henderson Lake sockeye target escapements have not been attained since 1993.

Recommended forecast

All three forecasting methods predict that 2003 returns of Barkley Sound sockeye will be above the long-term average and of a magnitude similar to the 2002 returns. The SStM forecast was recommended because of the method's superior overall performance. The SStM forecast for 2003 is 993,000 (50% CI, 667,000 – 1.30 million) for all ages and 922,000 (50% CI, 619,000 – 1.24 million) for adults. The Coho Leading Indicator (CLI) provided ancillary information on forecasts. It is based on the assumption that sea conditions in the smolt year affect marine survival. Coho smolts, sharing a given smolt year with sockeye smolts, will return one year earlier; smolt-to-

adult survival for coho may predict marine survival for sockeye. The CLI forecasts that the return will be in the upper portion of the 50% CI for the SStM forecast. Based on harvest strategy adopted in 1996, harvest projections under the SStM forecast range between 271,000 sockeye, given an SStM return of 673,000 (75% probability) to the Somass, and 565,000 with a return of 1.02 million (25% probability) to the Somass.

Subcommittee Conclusions

The Subcommittee accepted the SStM forecast for Barkley Sound sockeye. It is concerned about Henderson Lake not achieving its escapement target of 50,000 since 1994. The senior author noted that a Stock Status Paper on Henderson Lake sockeye will be presented at the May 2003 Salmon PSARC meeting.

Subcommittee Recommendations

The Subcommittee recommended that fisheries management consider avoiding Henderson Lake sockeye by modifying the timing and location of fisheries in Barkley Sound.

Subcommittee discussion regarding the timing of the March forecasting meeting

There was a special discussion regarding the timing of the forecasting meeting due to the apparent continual difficulty in having forecasts completed in a timely manner. This year, only one paper was submitted on time and the forecast paper for WCVI Chinook was not complete at the time of the meeting. The consensus was that there needs to be more support of data acquisition and data management, and even so, the biology of some of the species (late-spawners such as chinook) is such that an early March deadline is difficult to meet. The Subcommittee agreed that the March meeting should be scheduled one week later to accommodate this. There was also discussion related to the timely acquisition of CWT data. Mark-selective fisheries and the current voluntary system of returning heads of marked fish impedes the development of expansion factors which, in turn, ultimately impacts developing forecasts.

APPENDIX 1: Working Paper Summaries

S2003-01: Pre-season 2002 stock size forecasts for Skeena River and Nass River sockeye salmon

S. Cox-Rogers

This working paper presents pre-season forecasts for Skeena River and Nass River sockeye returning in 2003. The basic forecasts developed in this working paper were all based on procedures that performed best in past assessments. Three forecasting models were used to forecast Skeena sockeye returns in 2003, and one forecasting model was used to forecast Nass sockeye returns in 2003. The recommended median (50%) sibling model forecast for the 2003 Skeena return is 1,200,000. The recommended median (50%) 5-yr average return forecast for the 2003 Nass River sockeye return is 768,000. Other probability reference points are provided to facilitate risk adverse management decisions.

Working Paper S2003-02: Forecast for mainland inlet pink salmon in 2003

L. B. Holtby

This is the first formal forecast for the pink stocks of the mainland inlets and adjacent portions of Vancouver Island. The area was divided into six districts: north-east Vancouver Island, Johnstone Strait, mid-eastern Vancouver Island, Kingcome Inlet, Bond Sound to Knight Inlet and Loughborough to Bute Inlet. This forecast was requested by Central Coast Area managers as part of the response to the recruitment failures in Kingcome and Bond Sound/Knight Inlet districts in 2002. Standard forecasting techniques were used as previously applied to pink salmon in the central and northern coastal areas as well as coho salmon in the same areas. The performance of four time series models and a Ricker stock-recruitment model were compared retrospectively. In all six districts the Ricker model was the best performer and the forecasts are based on that model. Because each of the stocks is comprised of several to many spawning populations the forecasts were all done in index units. Therefore, the forecast abundance is not to be interpreted as a forecast of absolute abundance. Instead the forecasts are described relative to the observed median returns and to the theoretical management parameters derived from Ricker stock-recruitment models. In all cases the forecasts are highly uncertain because of the inherent variability in pink survival.

At the 50% forecast level, harvestable surpluses are expected in all districts. Surpluses are modest however and would be zero in some districts (e.g., mid-EVI) if more conservative forecast levels were used. Furthermore the possibility that the sea-lice infestations observed in 2002, although reported to be less severe than those seen in 2001, could impact survival of the Bond/Knight district, should temper pre-season expectations of harvest.

S2003-03: Forecast for southern and central British Columbia coho salmon in 2003

K. Simpson, M. Chamberlain, J. Fagan, B. Holtby, R. Sweeting, and R. Tanasichuk

This working paper presents 2003 forecasts of marine survival, abundance and distribution of coho in southern and central British Columbia (Areas 7 to 29: the Fraser River system and coastal waters south of approximately 53° N).

There are five hatchery and three wild coho indicator stocks in southern BC. Forecasts of survival for these stocks are:

Management Unit	Indicator	Recommended Model	Predicted Survival in 2003 (50% CI)		Change (2003 forecast minus 2002 observed S)
GBW	Big Qualicum	LLY	0.016	(0.010 - 0.027)	0%
	Quinsam	3YRA	0.014	(0.011 - 0.018)	8%
	Black (wild)	3YRA	0.043	(0.030 - 0.061)	-12%
LowFr	Chilliwack	RAT3	0.040	(0.029 - 0.055)	21%
	Inch	LLY	0.021	(0.009 - 0.047)	0%
	Salmon (wild)	LLY	0.063	(0.048 - 0.083)	0%
GBW,LowFr	All hatcheries	CPUE	0.014	(0.011 - 0.017)	-33%
SWVI, NWVI	Robertson	Sibling	0.042	(0.026 - 0.066)	-11%
	Carnation (wild)	Euphausiid	0.055	(0.053 - 0.058)	8%

Survivals are expected to range from 1.5% for hatcheries to 4.3% for higher productivity wild stocks on the west side of the Strait of Georgia (GBW). This represents little change from 2002. Survivals are also forecast to remain about the same in the lower Fraser area but at higher levels than on the Vancouver Island shore (6.3% for wild coho). Overall for the Georgia Basin, we characterise survivals as poor (GBW) to below average (Lower Fraser), basing this qualitative assessment on previously higher survivals and on calculations of the survivals needed to sustain stocks of low to average productivity. CPUE data also indicate low survivals, less than last year. There is little data for the east side of the Strait but other information suggests survivals are no better than in GBW.

Most coho originating in the Georgia Basin will probably rear equally in the Strait of Georgia and along the west coast of Vancouver Island.

On the west coast of Vancouver Island (wVI), survival of wild coho at Carnation Creek is forecast to be 5.5%, which is similar to the Georgia Basin survivals. Survival of Robertson Hatchery coho is forecast to be more than Georgia Basin hatcheries, as it has been for many years. These forecasts are similar to survivals in 2002. Both indicators are in SW Vancouver Island but results are also applied to NW Vancouver Island, which lacks indicators.

The abundance of Thompson River coho is expected to be 36,000. This is significantly less than the 51,000 in 2002 but more than the brood year abundance of 15,800. Returns in 2001 and 2002 also exceeded their brood year returns. This stock aggregate is slowly recovering.

The abundance forecasts for central British Columbia remain the only method of forecasting for this area. Forecasting methods conform to those of past forecasts in this area. The forecasts of total abundance for the five central coast aggregates are:

	Total return (abundance)		Escapement		
Aggregate	Forecast P †	Characterisation	Forecast P	Characterisation	% of S_{max}
Area 7	28%	below average	58%	average	38%
Area 8	15%	below average	40%	average	43%
Area 9/11	38%	average	91%	well above average	129%
Area 12	13%	well below average	48%	average	27%
Area 13	2%	well below average	19%	below average	6%

† Proportions of observed abundance or escapement less than the forecast value. These calculations assume a log-normal cumulative probability distribution with mean and standard deviation calculated over the observation period 1950 (1953 for Area 12 & 13) to 2002 (return years).

S2003-04: Forecast for Northern British Columbia coho salmon in 2003
J. Sawada, L.B. Holtby and B. Finnegan

This Working Paper documents abundance trends and forecasts of marine survival for the coho of northern coastal British Columbia (Statistical Areas 1 to 6), including the upper Skeena conservation area.

Observed Marine Survival in 2002:

Due to problems with the MRP database, marine survival for 2002 could not be determined at time of publication.

Forecasted Marine survival for 2003:

In 2003, marine survival at the three northern indicators is expected to be above or equal to the means of their respective periods of observation.

The period of observation is short for all three indicators. The survival rate of wild Toboggan Creek coho should be comparable to Lachmach but cannot be reliably forecast.

Indicator	S_{2003} (50% CI)	observed mean (period of observation, years of sea-entry)
Lachmach	0.130 (0.108-0.157)	0.10 (1987 –2000)
Toboggan Creek	0.044 (0.028-0.068)	0.039 (1987 –2000)
Fort Babine	0.023 (0.014-0.035)	0.025 (1993 –2000)

2003 Abundance forecast

Estimated smolt production from Lachmach in 2002 was 27,000, which is below the observed mean of 31,000 (1987 – 2000). That combined with above-mean marine survival produce a forecast return of 3,500 (50%CI: 2,900 - 4200) which is above mean (2,700) return observed over the period 1988 to 2002 (return years). The forecast of abundance for wild Toboggan coho is 1,800, which is considerably less than the mean total return of 4,700 (return years 1988 – 2002). Assuming an exploitation rate of 16% (i.e., same as 2002), the wild escapement to Toboggan would be 1,500, including terminal sport fisheries. That escapement is below the mean of the available observations (2,100; 1988 –2002). Abundance of Ft. Babine hatchery coho is forecast to be 680 (50%CI: 430 – 1,100). This return is below the mean of the time series (1,000; 1994 to 2001). Assuming an exploitation rate of 0.21, the mean exploitation rate of Lachmach, Toboggan and Zolzap in 2002, escapement of Ft. Babine hatchery coho would be 530.

The time series of abundance and the average-stream indices of the 6 north coastal aggregates show some indication of geographic patterning but do not indicate any conservation concerns in the area, with the possible exceptions of Area 4 upstream of the Babine confluence and Area 5. Escapement data are very poor in these Areas so it is difficult to determine the extent to which the poor escapements are due simply to limited data. For 2003, the total abundance and the escapement of coho to the Lachmach River are forecast to be above average. For Toboggan Creek wild and Ft. Babine hatchery, the forecast is expected to be below average. Without further investigation and a demonstration that status is actually better than indicated by the index used here, expansion of fisheries in the part of the coast should be discouraged.

S2003-05: Forecast for Central Coast (Areas 7 to 10) sockeye, pink and chum salmon in 2003

L.B. Holtby, P. Van Will and D. Lewis

The conservation concerns for both Owikeno and Long Lake sockeye remain, although returns improved significantly in 2002 and marine survival does appear to have returned to "normal". The concern remains because the returns for the next three years are off record low brood years in 1999 and 2000. Atnarko sockeye are recovering but the forecast remains below the DFO escapement target. Fisheries are not advisable on any

of these three stocks. No information is available for the Area 7 stock in Kimsquit Lake. Since its trajectory was similar to Owikeno's this stock might also be at risk.

Chum in Area 7 are forecast to be below target but well above the nominal DFO escapement targets in Areas 8, which should lead to a harvestable surplus in that area. Chum in Area 9 are depressed and no fisheries are advised in that area. There continues to be no information available on the chum of Area 10, which may be severely depressed. A recommendation to enumerate chum in Area 10 and to scrutinize the abundance of stocks to the south in Areas 11 to 13 is made again this year. The need to examine chum abundance in Areas 11-13 is especially important because of the possibility that chum fry suffered mortality from sea lice associated with the fish farms in the Broughton Archipelago during 2001 and 2002.

Odd-year pink are near near their nominal DFO escapement targets in Areas 7, 8, and 9. The forecast return in Area 9 is very uncertain. The record return in 2001 is well outside the historical range of observations and the Ricker stock-recruitment model predicts a zero-return. A time-series model was used to provide a forecast but fisheries management should anticipate the possibility of a recruitment failure in this area in 2003. No information is available to permit a forecast for Area 10 pink.

A summary of the forecasts and their characterization relative to established escapement targets is presented in the following table.

			No. fish (thousands)			
			Escapement			
Species	Area	Stock	Target	Forecast	50% CI	Characterisation
Sockeye	8	Atnarko	75	32	21 – 49	Depressed
	9	Owikeno	200	25	14 – 43	Critically depressed
	10	Long	200	9	3 – 26	Critically depressed
Chum	7	All	520	380	280 – 500	Below-target
	8	All	270	440	300 – 640	Abundant
	9	All	150	43	24 – 77	Depressed
Pink	7	All	440	700	390 –1,300	Near-target
	8	All	1,500	1,600	920 – 2,900	Near-target
	9	All	340	590	150 – 2,300	Near-target

S2003-06: Review of the year 2002 return of Barkley Sound Sockeye Salmon and Forecasts for 2002

K. Hyatt, W. Luedke, P. Rankin, J. Till and D. Lewis

Returns of Barkley Sound sockeye have exceeded the long-term average return of 820,000 adults for the past two years. Although variable, recent returns reflect the continuation of a pattern of predictable variations in ocean climate and survival conditions for juvenile sockeye salmon that have lead to repeated "crashes" (1978, 1985-86, 1989-90, 1994-95) followed within 1-4 years by recoveries (1979-81, 1987-88, 1991-93, 1996-98) of WCVI sockeye returns. The prolonged interval of sub-average

returns between 1994 and 2000 ended as anticipated in 2001 as ocean climate signals suggested increased marine survival rates for Barkley Sound sockeye smolts migrating seaward during the 1998-2000 interval.

Over the past 15 years, four independent techniques have been tested for their utility in generating reliable pre-season forecasts of Barkley Sound sockeye returns for harvest managers. The four techniques are known as the Salinity Survival Method (SSM), the Survival Stanza Method (SStM), the Sibling Age Class Method (SACM), and the Salmonid Enhancement Program Biostandard Method (SEPB). Updates on the performance of three of these techniques in the year 2002 are as follows:

(1) The SStM forecast exhibits the best overall performance by far with a mean absolute percent error (MAPE) value of 28% over the most recent 15 years of forecasting. SStM forecasts exhibit a statistically significant association with returns among all years (returns in thousands = 1.14 • SStM forecast in thousands + 55.19, $R^2 = 0.45$, $p<0.01$). They also account for the majority of variations in returns if the extreme observation associated with the 1991 return year (*when all forecasts techniques underestimated returns*) is omitted from the analysis (returns in thousands = 1.07 • SStM forecast in thousands + 21.71, $R^2 = 0.79$, $p<0.001$).

(2) The SEPB forecast exhibited the second best performance in predicting sockeye returns in 2002 (MAPE = 28%). However, to achieve a statistically significant association with returns among years, the extreme observation associated with the 1991 return year must be omitted from the analysis (returns in thousands = 1.36 • SEPB forecast in thousands - 462.57, $R^2 = 0.49$, $p< 0.01$). Further, during the 1988-2002 testing interval, SEPB forecasts exhibited a much higher MAPE value (58%) than that displayed by SStM forecasts (28%). Because large magnitude deviations between SEPB forecasts and actual returns tend to occur in consecutive years, it is viewed as having limited utility by both harvest managers and fishermen.

(3) The SSM forecast rivalled the SStM forecast in performance between the 1988-1999 testing interval. However, SSM forecasts have overestimated total returns of Barkley Sound sockeye by 490%, 83%, and 51% during the years 2000, 2001 and 2002 respectively. Thus, SSM forecasts now exhibit a MAPE that averages 68%. SSM forecasts do not exhibit a statistically significant association with returns among all years but do achieve significance if the extreme observation associated with the 1991 return year (*when all forecasts techniques underestimated returns*) is omitted from the analysis (returns in thousands = 0.35 • SSM forecast in thousands + 317, $R^2 = 0.28$, $p<0.05$).

Forecasts of Barkley Sound sockeye returns provided by different models vary greatly for 2003. Midpoint forecast estimates range from a low of 894,000 (SEPB model) to a high of 3,219,000 (SSM model) Barkley Sound sockeye of all ages. Comparative performance of the various forecast options, along with DFO's recent pursuit of a more risk averse approach to management recommends initial adoption of the SStM forecast range. Thus, 618,633 (75% probability) to 1,236,150 (25% probability) "adult" sockeye

(i.e. excludes "jacks") constitute the preferred, pre-season forecast range for the year 2003. Supplementary information from coho leading indicator observations suggests that returns are likely to be closer to the upper than the lower end of this range.

APPENDIX 2: PSARC Salmon Subcommittee Meeting Agenda March 4-5, 2003

PSARC Salmon Subcommittee Meeting
Re: Return Forecasts/Assessments
March 4-5, 2003
Seminar Room, PBS, Nanaimo

Tuesday March 4, 9:00

9:00 – 9:30 Introduction and procedures
9:30 – 10:15 Southern B. C. coho
10:15 – 10:30 Break
10:30 – 11:00 Southern B. C. coho cont.
11:00 – 12:00 Subcommittee Discussion re: Forecasting Meeting Re-scheduling
12:00 – 13:00 Lunch
13:00 – 14:15 Mainland Inlet Pink Salmon
14:15 – 14:45 Break
14:45 – 16:00 Review rapporteurs' report

Wednesday March 5, 8:30

8:30 –9:45 Skeena/Nass Sockeye
9:45-10:00 Break
10:00 – 11:15 CC Sockeye pink and chum
11:15-12:00 Northern B.C. Coho
12:00 – 13:00 Lunch
13:00-13:30 Northern B.C. Coho
13:30 – 14:45 Somass River Sockeye
14:45 – 15:00 Break
15:00 – 16:30 Review of rapporteurs' report

APPENDIX 3: List of Attendees

Subcommittee Chair: Ron Tanasichuk
PSARC Chair: Al Cass

DFO Participants	Tues.	Wed.	
* denotes Subcommittee Members			
Bailey, Richard	x		
Baillie, Steve	x		
Bates, George	x		
Brown, Gayle	x	x	
Cass, Al*	x	x	
Chamberlain, Mike	x		
Cook, Roberta*	x	x	
Cox-Rogers, Steve*	x	x	
Godbout, Lyse	x	x	
Goruk, Ron	x		
Hepples, Jonathan	x	x	
Holt, Kendra	x	x	
Holtby, Blair*	x	x	
Hyatt, Kim*		x	
Ionson, Bert*	x	x	
Irvine, Jim*	x		
Luedke, Wilf*	x		
McNicol, Rick		x	
Meerberg, Dave*	x	x	
Parken, Chuck*	x		
Sawada, Joel	x	x	
Simpson, Kent*	x		
Sullivan, Melanie*	x	x	
Tadey, Joe	x		
Tanasichuk, Ron*	x	x	
Thomas, Greg	x	x	
Tompkins, Arlene	x		
Yockey, Cindy	x	x	
External Participants:			**Affiliation**
Atkinson, Mary-Sue		x	PFRCC
Galesloot, Mike	x	x	Shuswap Nation Fisheries Commission
Harling, Wayne		x	BC Fish and Wildlife Federation
Kristianson, Gerry	x	x	Sport Fish Advisory Board
Riddell, Brian		x	PFRCC

Rombough, Les	x	x	Fraser River Panel
Shepert, Marcel	x	x	PFRCC
Observers			**Affiliation**
Blackbourn, David	x	x	Consultant
Scarfo, Kathy	x	x	Area G Troll Association
Wilson, Ken	x	x	Fraser River Aboriginal Fisheries Secretariat

List of Rapporteurs

Rapporteurs for the PSARC papers presented at this meeting are listed below in alphabetical order. Their assistance was invaluable in recording the Subcommittee discussion, conclusions and recommendations at this meeting.

Brown, Gayle
Cooke, Roberta
Hepples, Jonathon
Parken, Chuck
Rankin, Paul
Yockey, Cindy

Tables and Figures

Table 1: Recommended pre-season forecasts of Skeena and Nass Rivers sockeye salmon stock size in 2003. a - Nisga'a Fisheries Estimate (return to Canada).

Stock	Escapement target	Forecasts for reference probabilities 25%	50%	75%	90%
Skeena	1,050,000	1,739,000	1,205,000	835,000	595,000
Nass	200,000	921,000	768,000	640,000	527,000
Nass			867,000[a]		

Table 2: Central Coast mainland pink abundance forecasts for 2003. EVI – east coast Vancouver Island.

	Forecasts at specific probabilities			Median	Percent	
District	25%	50%	75%	return	S_{MSY}	S_{max}
North EVI	2,400	4,800	9,400	178	129	74
Johnstone Strait	8,200	18,000	41,000	121	240	186
Mid EVI	7,800	20,000	49,000	124	115	69
Kingcome	15,000	64,000	270,000	87	175	156
Bond/Knight	23,000	49,000	100,000	53	148	109
Loughborough/Bute	9,700	19,000	39,000	85	171	117

Table 3: A comparison of the predictive power of abundance versus return per spawner based models for southern B.C. coho using retrospective analysis.

North Thompson

MA-1 model (Like Last Year)						MA-3 (moving 3 yr average)					
ABUNDANCE BASED MODEL			RETURN PER SPAWNER			ABUNDANCE BASED MODEL			RETURN PER SPAWNER		
1979-2002	*RMSE*	81609	1979-2002	*RMSE*	175348	1982-2002	*RMSE*	65234	1982-2002	*RMSE*	127163
	MAD	61443		MAD	107424		MAD	49265		MAD	79453
	n	24		*n*	24		*n*	21		*n*	21
	stdev:	0.8790		stdev:	1.3589		stdev:	0.7845		stdev:	1.1505
1990-2002	*RMSE*	39023	1990-2002	*RMSE*	46857	1990-2002	*RMSE*	36037	1990-2002	*RMSE*	44053
	MAD	30073		MAD	36127		MAD	27800		MAD	31606
	n	13		*n*	13		*n*	13		*n*	13
	stdev:	0.9435		stdev:	1.0723		stdev:	0.8372		stdev:	1.0353

South Thompson

MA-1 model (Like Last Year)						MA-3 (moving 3 yr average)					
ABUNDANCE BASED MODEL			RETURN PER SPAWNER			ABUNDANCE BASED MODEL			RETURN PER SPAWNER		
1979-2002	*RMSE*	20315	1979-2002	*RMSE*	27134	1981-2002	*RMSE*	18614	1981-2002	*RMSE*	31619
	MAD	13324		MAD	19360		MAD	13800		MAD	20564
	n	27		*n*	24		*n*	22		*n*	22
	stdev:	0.6927		stdev:	1.3326		stdev:	0.7229		stdev:	0.9172
1990-2002	*RMSE*	21307	1990-2002	*RMSE*	20780	1990-2002	*RMSE*	17927	1990-2002	*RMSE*	23356
	MAD	13105		MAD	14084		MAD	12823		MAD	14388
	n	13		*n*	13		*n*	13		*n*	13
	stdev:	0.8850		stdev:	1.1605		stdev:	0.7960		stdev:	0.9026

Lower Thompson

MA-1 model (Like Last Year)						MA-3 (moving 3 yr average)					
ABUNDANCE BASED MODEL			RETURN PER SPAWNER			ABUNDANCE BASED MODEL			RETURN PER SPAWNER		
1988-2002	*RMSE*	20070	1988-2002	*RMSE*	17661	1990-2002	*RMSE*	17478	1990-2002	*RMSE*	18201
	MAD	11076		MAD	11065		MAD	10871		MAD	12049
	n	15		*n*	15		*n*	13		*n*	13
	stdev:	0.8136		stdev:	1.0424		stdev:	0.9064		stdev:	1.1236
1990-2002	*RMSE*	21490	1990-2002	*RMSE*	18668	1990-2002	*RMSE*	17478	1990-2002	*RMSE*	18201
	MAD	12106		MAD	11484		MAD	10871		MAD	12049
	n	13		*n*	13		*n*	13		*n*	13
	stdev:	0.8649		stdev:	1.0654		stdev:	0.9064		stdev:	1.1236

Total Thompson

MA-1 model (Like Last Year)						MA-3 (moving 3 yr average)					
ABUNDANCE BASED MODEL			RETURN PER SPAWNER			ABUNDANCE BASED MODEL			RETURN PER SPAWNER		
1988-2002	*RMSE*	20070	1988-2002	*RMSE*	157572	1990-2002	*RMSE*	17478	1990-2002	*RMSE*	71054
	MAD	11076		MAD	88587		MAD	10871		MAD	52437
	n	15		*n*	15		*n*	13		*n*	13
	stdev:	0.8136		stdev:	0.9738		stdev:	0.9064		stdev:	0.5750
1990-2002	*RMSE*	21490	1990-2002	*RMSE*	66957	1990-2002	*RMSE*	17478	1990-2002	*RMSE*	71054
	MAD	12106		MAD	45729		MAD	10871		MAD	52437
	n	13		*n*	13		*n*	13		*n*	13
	stdev:	0.8649		stdev:	0.9067		stdev:	0.9064		stdev:	0.5750

Table 4: Southern B.C. coho survival rate forecasts.

Management Unit	Indicator	Recommended Model	Predicted Survival in 2003 (50% CI)		Change (2003 forecast minus 2002 observed S)
GBW	Big Qualicum	LLY	0.016	(0.010 - 0.027)	0%
	Quinsam	3YRA	0.014	(0.011 - 0.018)	8%
	Black (wild)	3YRA	0.043	(0.030 - 0.061)	-12%
LowFr	Chilliwack	RAT3	0.040	(0.029 - 0.055)	21%
	Inch	LLY	0.021	(0.009 - 0.047)	0%
	Salmon (wild)	LLY	0.063	(0.048 - 0.083)	0%
GBW,LowFr	All hatcheries	CPUE	0.014	(0.011 - 0.017)	-33%
SWVI, NWVI	Robertson	Sibling	0.042	(0.026 - 0.066)	-11%
	Carnation (wild)	Euphausiid	0.055	(0.053 - 0.058)	8%

Table 5: Forecasts of total abundance for Thompson River watershed coho in 2003 and associated confidence intervals. All forecasts are based on the 3YRA 'abundance-based' model. The number of years in each time series is given (n).

	Lower Thompson		South Thompson		North Thompson		Total Thompson	
CI	Return	% of Mean	Return	% of Mean	Return	% of Mean	Return	% of Mean
	n=16		n=25		n=25		n=16	
99%	83,000	829%	47,000	263%	120,000	195%	230,000	272%
95%	41,000	409%	28,000	156%	63,000	103%	130,000	154%
90%	29,000	289%	21,000	117%	47,000	77%	94,000	111%
75%	17,000	170%	14,000	78%	28,000	46%	59,000	70%
50%	**9,600**	**96%**	**8,500**	**47%**	**17,000**	**28%**	**36,000**	**43%**
25%	5,400	54%	5,300	30%	9,800	16%	22,000	26%
10%	3,200	32%	3,400	19%	6,000	10%	14,000	17%
5%	2,300	23%	2,600	15%	4,400	7%	10,000	12%
1%	1,100	11%	1,500	8%	2,400	4%	5,400	6%

Table 6: Forecast characterisations for the Central Coast coho aggregates considered. Forecasts were made using the 3YRA model. Probability values between 35% and 65% were characterised as average; probabilities less than 15% or greater than 85% were characterised as either well below or well above average respectively.

	Total return (abundance)		Escapement		
Aggregate	Forecast P †	Characterisation	Forecast P	Characterisation	% of S_{max}
Area 7	28%	below average	58%	average	38%
Area 8	15%	below average	40%	average	43%
Area 9/11	38%	average	91%	well above average	129%
Area 12	13%	well below average	48%	average	27%
Area 13	2%	well below average	19%	below average	6%

† Proportions of observed abundance or escapement less than the forecast value. These calculations assume a log-normal cumulative probability distribution with mean and standard deviation calculated over the observation period 1950 (1953 for Area 12 & 13) to 2002 (return years).

Table 7: Marine survival rate forecasts for the North coast coho indicator stocks. Forecasts for Lachmach River are based on a sibling regression model. Forecasts for the other stocks are based on covariations with Lachmach River survival rates. Toboggan Creek and Fort Babine are hatchery stocks.

Indicator	S_{2003} (50% CI)	observed mean (period of observation, years of sea-entry)
Lachmach	0.130 (0.108-0.157)	0.10 (1987 –2000)
Toboggan Creek	0.044 (0.028-0.068)	0.039 (1987 –2000)
Fort Babine	0.023 (0.014-0.035)	0.025 (1993 –2000)

Table 8: 2003 forecasts of total stock sizes for the three Central Coast sockeye stocks considered. The 5YRA method was used for each forecast.

	Area: stock		
	8: Atnarko	9: Owikeno	10: Long
escapement target	75,000	200,000	200,000
probability of smaller total stock size			
99%	120,000	190,000	450,000
95%	94,000	100,000	130,000
90%	73,000	73,000	72,000
75%	49,000	43,000	26,000
50%	32,000	25,000	8,600
25%	21,000	14,000	2,800
10%	14,000	8,300	1,000
5%	11,000	6,000	550
1%	6,800	3,300	160

Table 9: 2003 forecasts total stock sizes for the three Central Coast odd-year pink stock aggregates. The Ricker stock-recruitment method was used for all areas. The 3CYA forecast is provided for Area 9 because of concerns about the utility of the Ricker model given the record returns in the brood year to that area.

	Area			
	7	8	9 (SR)	9 (3CYA)
Escapement target	440,000	1,500,000	340,000	340,000
S_{MSY}	340,000	900,000	73,000	73,000
Probability of smaller total stock size				
99%	5,100,000	13,000,000	4,000,000	82,000,000
95%	2,700,000	6,700,000	59,000	17,000,000
90%	2,000,000	4,800,000	7,100	8,000,000
75%	1,300,000	2,900,000	260	2,300,000
50%	700,000	1,600,000	7	590,000
25%	390,000	920,000	0	150,000
10%	250,000	550,000	0	44,000
5%	180,000	400,000	0	20,000
1%	96,000	210,000	0	4,200

Table 10: 2003 forecasts of total stock size for three Central Coast chum stocks. The nYRA method was used for all areas.

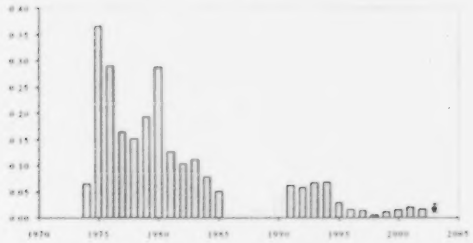
	Area		
	7	8	9
escapement target	520,000	270,000	150,000
probability of smaller total stock size			
99%	1,000,000	1,800,000	380,000
95%	760,000	1,200,000	190,000
90%	640,000	920,000	140,000
75%	500,000	640,000	77,000
50%	380,000	440,000	43,000
25%	280,000	300,000	24,000
10%	220,000	210,000	13,000
5%	190,000	170,000	9,600
1%	140,000	110,000	4,800

Table 11: Barkley Sound sockeye escapement summary. * - preliminary estimate.

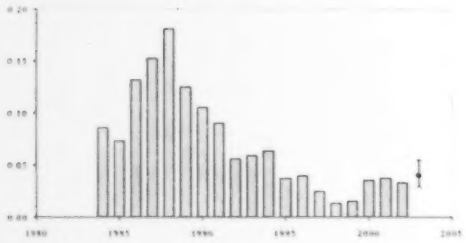
Return Year	Total	Henderson	Lake Great Central	Sproat
1977	298,000	5,000	212,000	81,000
1978	159,000	7,000	114,000	38,000
1979	360,000	20,000	264,000	76,000
1980	319,000	21,000	160,000	138,000
1981	430,000	40,000	262,000	128,000
1982	470,000	56,000	172,000	242,000
1983	645,000	45,000	350,000	250,000
1984	268,000	45,000	133,000	89,000
1985	300,000	25,000	128,000	147,000
1986	316,000	5,000	118,000	193,000
1987	436,000	29,000	255,000	152,000
1988	460,000	30,000	195,000	235,000
1989	425,000	38,000	219,000	168,000
1990	324,000	35,000	177,000	112,000
1991	698,000	50,000	437,000	211,000
1992	429,000	27,000	191,000	211,000
1993	541,000	120,000	238,000	183,000
1994	265,000	15,000	107,000	144,000
1995	169,000	3,000	64,000	102,000
1996	325,000	21,000	120,000	184,000
1997	321,000	21,000	174,000	126,000
1998	453,000	30,000	236,000	187,000
1999	392,000	4,000	215,000	173,000
2000	216,000	16,000*	76,000	125,000
2001	786,000	4,000*	411,000	372,000
2002	521,000	16,000*	285,000	220,000

Fig. 1: Marine survival rate time series for southern B.C. coho indicator stocks. Forecasts are shown as square symbols and bars indicate the 50% CL's. Quinsam, Big Qualicum and Black are from the east coast of Vancouver Island. Inch, Chilliwack and Salmon are lower Fraser stocks. Robertson and Carnation are from the southwest coast of Vancouver Island. Open bars for Big Qualicum indicate suspect survival rates because of fish culture difficulties.

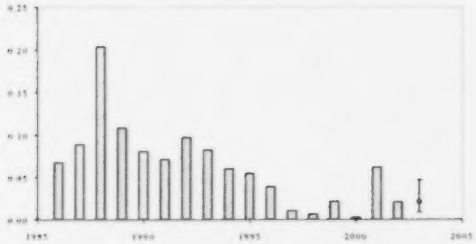
Big Qualicum, hatchery



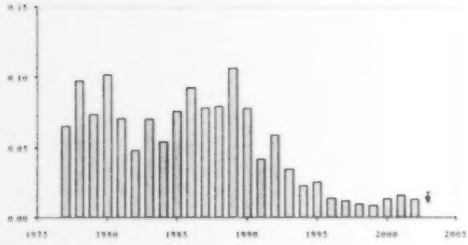
Chilliwack, hatchery



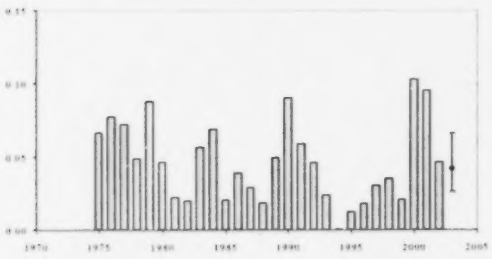
Inch, hatchery



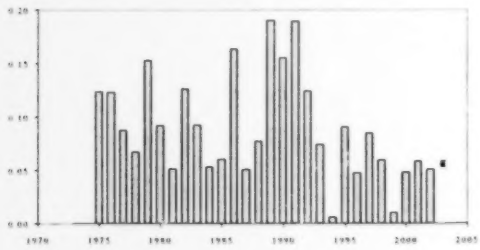
Quinsam, hatchery



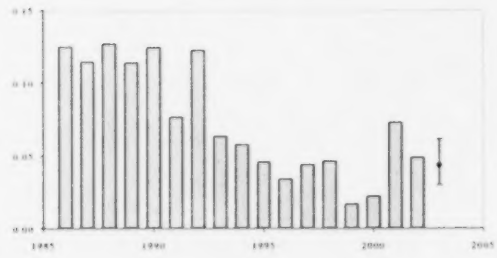
Robertson, hatchery



Carnation, wild



Black, wild



Salmon (Langley), wild

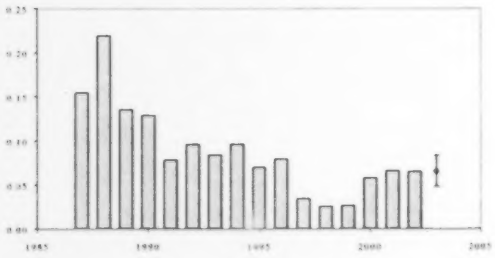


Fig. 2: Time series of total stock size and escapement for the four Central Coast sockeye stocks considered. There is no information for 2002 returns for Kimsquit at the time of writing. Abundance has been plotted on a log10 scale. The horizontal dashed line is the nominal CDFO aggregate target escapement. (CDFO= Fisheries and Oceans Canada)

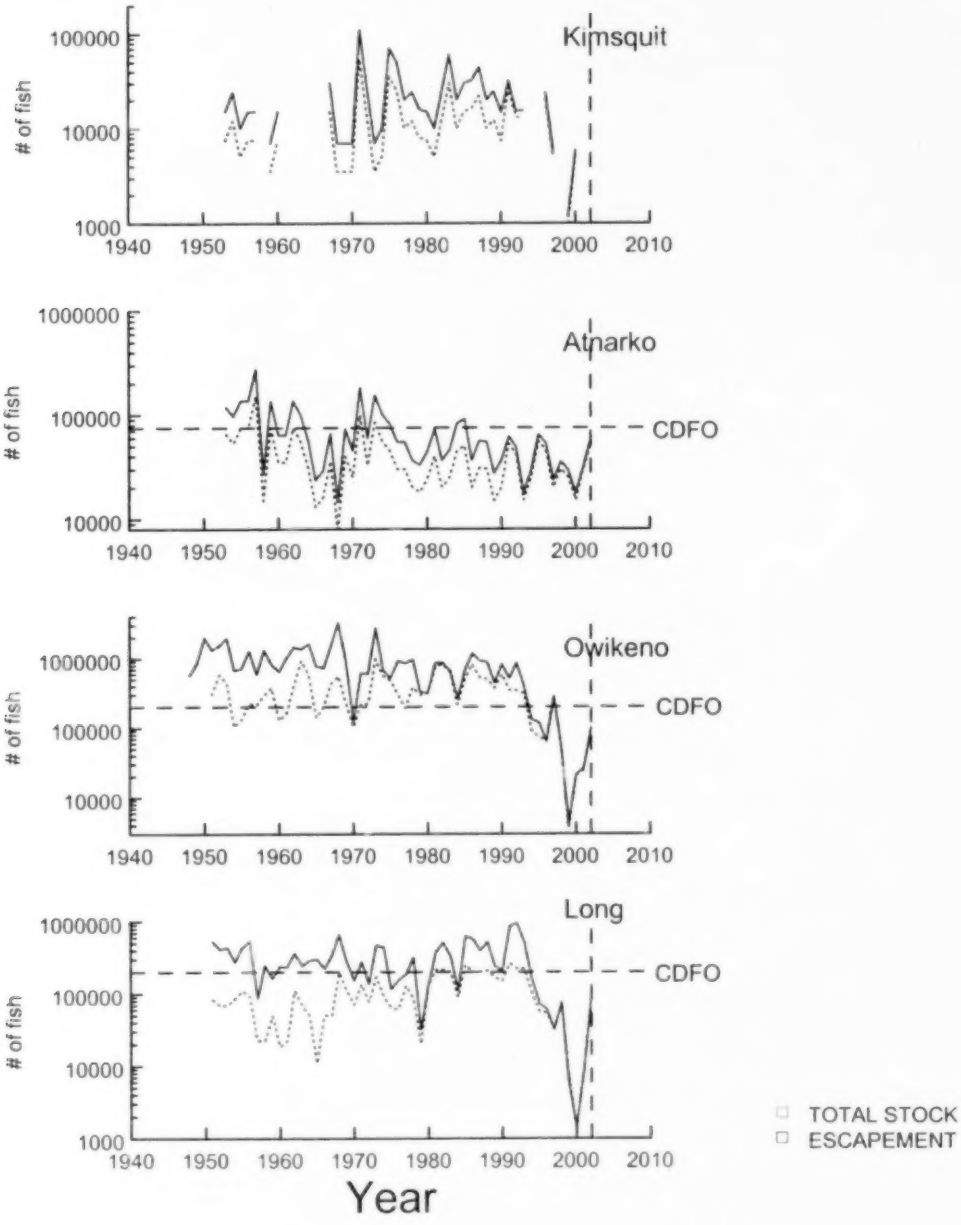


Fig. 3: Time series of total stock size and escapement for the four Central Coast chum stocks considered. There is no information for 2002 returns Area 10 at the time of writing. Abundance has been plotted on a log10 scale.

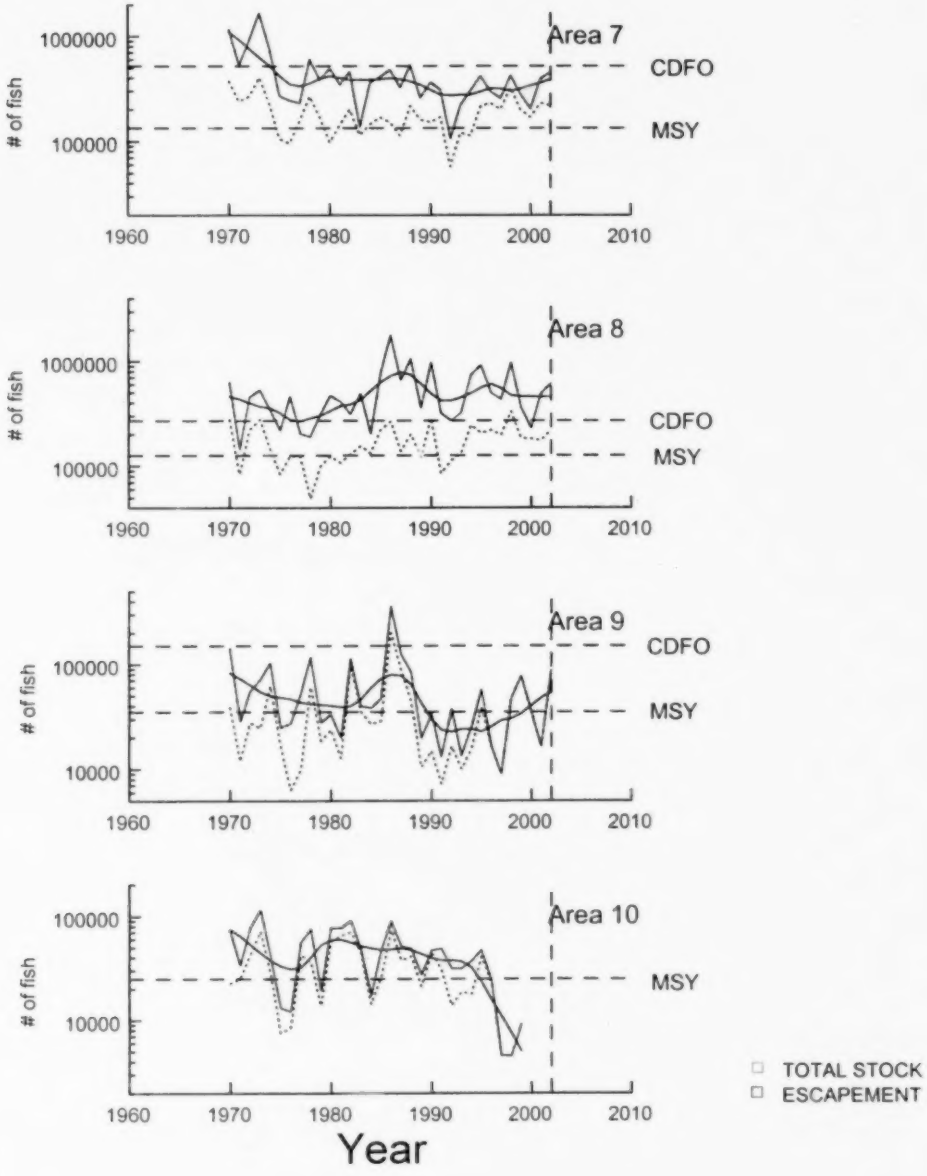


Fig. 4: Time series of total stock size and escapement for the four Central Coast odd-year pink stocks considered. In each plot the lower horizontal dashed line is the estimated value of S_{MSY} for the aggregate. The upper horizontal dashed line is the nominal CDFO aggregate target escapement. The vertical dashed lines identify the brood year 2001. Pink returns to Area 10 were not enumerated in 2001. Abundance has been plotted on a log10 scale.